WHAT IS CLAIMED IS:

1. A capacity control valve for a variable displacement compressor that regulates a flow rate of refrigerant discharged by the variable displacement compressor, comprising:

a first control valve that sets a specific cross-sectional area of a refrigerant passageway that leads to a suction chamber or a discharge chamber of the variable displacement compressor;

a second control valve that senses differential pressure developed across the first control valve and controls a flow rate of refrigerant supplied to or coming out of a crank chamber of the variable displacement compressor in such a way that the differential pressure will be maintained at a specified level; and

a solenoid unit that actuates the first control valve to set the cross-sectional area of the refrigerant passageway according to variations in a given external condition,

wherein the first control valve, second control valve, and solenoid unit are integrally formed.

2. A capacity control valve for a variable displacement compressor that regulates a flow rate of refrigerant discharged by the variable displacement compressor, comprising:

a first control valve that sets a specific cross-

sectional area of a refrigerant passageway that leads to a suction chamber or a discharge chamber of the variable displacement compressor;

a second control valve and a third control valve that sense differential pressure developed across the first control valve and respectively control flow rates of refrigerant supplied to and coming out of a crank chamber of the variable displacement compressor in such a way that the differential pressure will be maintained at a specified level; and

a solenoid unit that actuates the first control valve to set the cross-sectional area of the refrigerant passageway according to variations in a given external condition,

wherein the first, second, and third control valves and solenoid unit are integrally formed.

3. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway leading from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, actuated by an upstream force that is produced and controlled by the solenoid unit while

being urged by a downstream force in a valve-closing direction; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat while being urged by upstream-end pressure of the first control valve, and

a piston receiving downstream-end pressure of the first control valve and impelling the second valve element in a valve-closing direction with the received downstream-end pressure.

4. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway leading from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, actuated by a downstream force that is produced and controlled by the solenoid unit while being urged in a valve-closing direction when the solenoid unit is de-energized; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat while being urged by upstream-end pressure of the first control valve, and

a piston receiving downstream-end pressure of the first control valve and impelling the second valve element in a valve-closing direction with the received downstream-end pressure.

5. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway leading from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move downstream toward and upstream away from the first valve seat while being forced in a valve-opening direction, actuated by a force that is produced and controlled by the solenoid unit;

the second control valve comprises:

a second valve seat formed as part of a passageway

that leads from the downstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat while receiving downstream-end pressure of the first control valve, and

a piston receiving, on one endface thereof, upstream-end pressure of the first control valve and thereby impelling the second valve element in a valve-closing direction; and

the capacity control valve further comprises a communication hole between the first and second control valves to connect a space adjacent to the pressure receiving endface of the piston with an upstream-end space of the first control valve.

6. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a spool valve disposed in the refrigerant passageway coming from the discharge chamber, comprising a spool-shaped first valve element, and

a pressure responsive piston that is integrally formed with, and has the same diameter as, the first valve element of the spool valve, having a pressure balancing hole therethrough to cause an endface thereof remote from the first valve element to receive valve hole pressure of

the spool valve; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat, and

a pressure responsive member integrally formed with the second valve element, one end thereof serving as a first valve seat receiving the first valve element of the spool valve, impelling the second valve element in response to differential pressure developed across the spool valve.

7. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a spool valve disposed in the refrigerant passageway coming from the discharge chamber, comprising a spool-shaped first valve element, and

a pressure responsive piston that is integrally formed with, and has the same diameter as, the first valve element of the spool valve, having a pressure balancing hole therethrough to cause valve hole pressure of the spool valve to act on an endface of the pressure responsive piston remote from the first valve element; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat while being forced in a valve-closing direction, and

a pressure responsive member impelling the second valve element through a valve hole thereof in response to differential pressure developed across the spool valve, one end of the pressure responsive member serving as a first valve seat receiving the first valve element of the spool valve.

8. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve element with a taper-shaped end, disposed in the refrigerant passageway coming from the discharge chamber, being urged by a downstream force in a valve-closing direction that is produced by the solenoid unit in de-energized state; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat while being forced in a valve-closing direction, and

a pressure responsive member impelling the second valve element through a valve hole thereof in response to differential pressure developed across the first control valve, one end of the pressure responsive member serving as a first valve seat receiving the first valve element of the first control valve.

9. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a taper valve with a first valve element disposed in the refrigerant passageway coming from the discharge chamber, being urged by a downstream force that is produced by the solenoid unit in de-energized state and acts on the first valve element in a valve-closing direction,

a pressure responsive piston integrally formed with the first valve element of the taper valve, with the same diameter as a valve hole of the taper valve, having a pressure balancing hole therethrough to cause valve hole pressure of the taper valve to act on an endface of the pressure responsive piston remote from the first valve element; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat while being forced in a valve-closing direction, and

a pressure responsive member impelling the second valve element through a valve hole thereof in response to differential pressure developed across the taper valve, one end of the pressure responsive member serving as a first valve seat receiving the first valve element of the taper valve.

10. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a plurality of first valve seats formed as downstream-side edges of a plurality of valve holes, the valve holes being arranged along a circle so as to constitute a part of the refrigerant passageway coming from the discharge chamber, and

a plurality of ball-shaped first valve elements disposed in a downstream-side space adjacent to the respective first valve seats, being urged by an upstream force in a valve-closing direction that is produced by the

solenoid unit in de-energized state; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat, and

a pressure responsive member integrally formed with the second valve element, impelling the second valve element in response to differential pressure developed across the first control valve.

11. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as a downstream-side edge of a doughnut-shaped valve hole, the valve hole being hollowed so as to constitute a part of the refrigerant passageway coming from the discharge chamber,

a first valve element located opposite the first valve seat, being urged by an upstream force in a valve-closing direction that is produced by the solenoid unit in de-energized state; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control

valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat, and

a pressure responsive member integrally formed with the second valve element, impelling the second valve element in response to differential pressure developed across the first control valve.

12. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a cylinder constituting a part of the refrigerant passageway coming from the discharge chamber, the downstream end thereof serving as a first valve seat, and

a first valve element located opposite the first valve seat, integrally formed with a plunger of the solenoid unit, being urged by a force in a valve-closing direction that is produced by the solenoid unit in de-energized state; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat,

a pressure responsive piston integrally formed with the second valve element, with the same diameter as a valve hole of the second valve seat,

a communication hole that propagates upstream-end pressure of the first control valve to an endface of the pressure responsive piston remote from the second valve element,

a sliding member slidably fitted on an outer surface of the cylinder, and

a diaphragm disposed between the sliding member and a body, impelling the second valve element in response to differential pressure developed across the first control valve.

13. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a cylinder constituting a part of the refrigerant passageway coming from the discharge chamber, the upstream end thereof serving as a first valve seat, and

a first valve element located opposite the first valve seat, being urged by a force in a valve-closing direction that is produced by the solenoid unit in de-energized state; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control

valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat, and

a sliding member slidably fitted on an outer surface of the cylinder, and

a diaphragm disposed between the sliding member and a body, impelling the second valve element in response to differential pressure developed across the first control valve.

14. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway leading from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the crank chamber to the suction chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat,

a first piston integrally formed with the second valve element, receiving upstream-end pressure of the first control valve and impelling the second valve element in a valve-closing direction with the received upstream-end pressure, and

a second piston integrally formed with the second valve element, receiving downstream-end pressure of the first control valve and impelling the second valve element in a valve-opening direction with the received downstream-end pressure.

15. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat,

a piston integrally formed with the second valve element, having substantially the same diameter as a valve hole of the second valve seat, receiving downstream-end pressure of the first control valve, and

a pressure responsive piston installed coaxially with the second valve element, causing the second valve element to move in a valve-opening direction in response to upstream-end pressure of the first control valve, also causing the second valve element to move in a valve-closing direction in response to the downstream-end pressure of the first control valve.

16. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the

refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the crank chamber to the suction chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat, and

first and second pistons formed integrally and coaxially with the second valve element at both ends thereof, the distal endfaces of the first and second pistons having substantially equal areas to receive downstream-end pressure of the first control valve, and

a pressure responsive piston installed coaxially with the second valve element, causing the second valve element to move in a valve-closing direction in response to upstream-end pressure of the first control valve, also causing the second valve element to move in a valve-opening direction in response to downstream-end pressure of the first control valve.

17. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber,

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat, and

a pressure responsive piston installed coaxially with the second valve element, causing the second valve element to move in a valve-opening direction in response to upstream-end pressure of the first control valve, also causing the second valve element to move in a valve-closing direction in response to downstream-end pressure of the first control valve.

18. The capacity control valve according to claim 1, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction; and

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the crank chamber to the suction chamber,

a second valve element located opposite the second valve seat, allowed to move downstream toward and upstream away from the second valve seat, and

a pressure responsive piston installed coaxially with the second valve element, causing the second valve element to move in a valve-closing direction in response to upstream-end pressure of the first control valve, also causing the second valve element to move in a valve-opening direction in response to downstream-end pressure of the first control valve.

19. The capacity control valve according to claim 2, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction;

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the upstream end of the first control valve to the crank chamber, and

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat; and

the third control valve comprises:

a third valve seat formed as part of a passageway that leads from the crank chamber to the suction chamber,

a third valve element integrally formed with the second valve element, located opposite the third valve seat, allowed to move downstream toward and upstream away from the third valve seat, and

a piston integrally formed with the third valve element, receiving downstream-end pressure of the first

control valve and impelling the second valve element in a valve-closing direction and the third valve element in a valve-opening direction with the received downstream-end pressure.

20. The capacity control valve according to claim 2, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber, and

a first valve element located opposite the first valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction;

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber, and

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat; and

the third control valve comprises:

a third valve seat formed as part of a passageway

that leads from the crank chamber to the suction chamber,

a third valve element integrally formed with the second valve element, located opposite the third valve seat, allowed to move downstream toward and upstream away from the third valve seat,

a piston integrally formed with the third valve element, receiving downstream-end pressure of the first control valve and impelling the second valve element in a valve-closing direction and the third valve element in a valve-opening direction with the received downstream-end pressure, and

a pressure responsive piston installed coaxially with the second and third valve elements, actuating the second valve element in a valve-opening direction and the third valve element in a valve-closing direction in response to upstream-end pressure of the first control valve, also actuating the second valve element in the valve-closing direction and the third valve element in the valve-opening direction in response to downstream-end pressure of the first control valve.

21. The capacity control valve according to claim 2, wherein:

the first control valve comprises:

a first valve seat formed as part of the refrigerant passageway coming from the discharge chamber,

a first valve element located opposite the first

valve seat to set the cross-sectional area of the refrigerant passageway, allowed to move upstream toward and downstream away from the first valve seat, actuated by a downstream force that is produced and controlled by the solenoid unit while being forced in a valve-closing direction;

the second control valve comprises:

a second valve seat formed as part of a passageway that leads from the downstream end of the first control valve to the crank chamber, and

a second valve element located opposite the second valve seat, allowed to move upstream toward and downstream away from the second valve seat; and

the third control valve comprises:

a third valve seat formed as part of a passageway that leads from the crank chamber to the suction chamber,

a third valve element integrally formed with the second valve element, located opposite the third valve seat, allowed to move downstream toward and upstream away from the third valve seat, and

a pressure responsive piston installed coaxially with the second and third valve elements, causing the second valve element move in a valve-opening direction and the third valve element in a valve-closing direction in response to upstream-end pressure of the first control valve, also causing the second valve element to move in the valve-closing direction and the third valve element in

the valve-opening direction in response to downstream-end pressure of the first control valve.